ORIGINS SUBCOMMITTEE (OS) MEETING

Jet Propulsion Laboratory
February 27-28, 2003

Letter to Dr. Andrew Christensen, Chair of the Space Science Advisory Committee

Dear Dr. Christensen:

The Origins Subcommittee met at the Jet Propulsion Laboratory on February 27 and 28, 2003. As part of this meeting a joint session of OS & SEUS was addressed by both Astronomy & Physics Director Anne Kinney and Associate Administrator Ed Weiler. The President's FY04 proposed budget, described by Kinney and Weiler, shows strong support for space science in general and the A&P program in particular. The OS was particularly gratified that the Beyond Einstein Initiative is part of the proposed budget, and that funding of the Origins program is slated to increase in FY04, and projected to continue to grow in 2005-2008.

The loss of the Columbia Space Shuttle with its dedicated crew often sounded a somber note in our discussions. The OS joins the community in expressing its condolences to the family and friends of the Columbia crew and hopes that a rapid and safe return to operational status can be accomplished. We are all aware of the great risk the astronauts take in the name of science; the refurbishment missions of the Hubble Space Telescope are perhaps the best example of the way human spaceflight can enable and enhance mainline science. With a vital servicing mission (SM-4) scheduled at the end of 2004, the fate of HST is irrevocably tied to the Shuttle program. At this meeting we heard a description by Jim Green of the Cosmic Origins Spectrograph scheduled for installation in SM-4. Because of an increased sensitivity of nearly an order-of-magnitude over STIS for high-resolution UV spectroscopy, the contribution of COS to the study of galaxy evolution from the point of view of the baryonic gas, and to the nature of the interstellar medium, will be unprecedented and invaluable. We all recognize the critical importance of installing both COS and WFC-3, which we heard about at our December 2002 meeting, in HST, along with the preparation of the telescope for the final years of its mission.

SAFIR

We were treated to a description of the proposed mission SAFIR by Dan Lester. This successor to SIRTF is intended to build on JWST technology to achieve an aperture at least as large, which is crucial for increasing spatial resolution in the mid- to far-IR, where SIRTF will often be confusion-limited. Furthermore, SAFIR is to operate even colder than JWST – below 10ºK – so that its sensitivity will be limited only by the glow of zodiacal light. With its much sharper and deeper view into the universe as revealed in dust-emitted radiation beyond 50μm, SAFIR will address key elements of the Origins theme, in particular, understanding the first generations of stars in the early universe, and the processes by which planets are born around young stars. ***The OS acknowledges the support of SAFIR by the McKee-Taylor 2000 Decadal Survey of Astronomy & Astrophysics and endorses a growing program of technology development for this important mission of the next decade.***

Origins Technology

James Breckenridge reported on his efforts to bring greater focus and coherence to technology efforts that support Origins missions and goals. Through the JPL Origins office, Breckenridge is organizing a program that will track and advise the diverse and rather dispersed technology efforts that are occurring at NASA centers, universities, and at commercial companies. For example, large, lightweight optics, robust cryo-coolers, higher efficiency and larger-format UV detectors, and IR-arrays with lower read noise and dark currents will be key components of future strategic missions as well as essential components of Explorer and Discovery class programs. Because these smaller missions rely on mature technologies, it is especially important that new technologies be brought fully up to TRL6: a "TRL-gap" has too often prevented implementation because otherwise well-developed technologies have not been carried further to flight-ready status. We were particularly enthusiastic about Code-R's increasing interest in developing technology for Code-S missions, and support Jim Breckenridge's plan to bring all the stakeholders in technology development together for a workshop later this year.

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OSS Science Strategy

Phil Crane led a discussion of the new document that blends elements of the theme roadmaps and the NASA Strategic Plan to formulate a science strategy for OSS. A draft was provided to the OS for review and comment. The document contained a brief but excellent description of the Origins programs, and the strategy for pursuing Origins goals. Suggestions were made for improvement, particularly in the R&A discussion. The OS felt strongly the role of theory in fomenting new ideas and shaping future missions was understated in the Strategy. Hashima Hasan and I collected these suggestions for revised wording and new text; these were discussed at the following week's SScAC meeting and submitted by me in writing to Lisa May.

SOFIA

The OS was pleased to hear from Tom Greene that SOFIA is on track to begin flights at the end of 2004, with tests of the telescope and instruments to begin in 2005 and probable routine science operations in 2006. Recent highlights of the project include two milestones – completion of the aircraft structural modifications and the installation of the 2.5-m telescope. The first-light instrument strategy was presented and discussed. The OS is supportive of the project's goal to bring on-line three facility instruments in the first year. The OS encourages the project to give particular attention to ensuring that some high-impact science is accomplished and publicized during the first year of operations. We were disappointed to hear that SOFIA will begin operations with separate US and German time-allocation committees. A joint, multi-national TAC, such as has been implemented since the start of Hubble Space Telescope, is more likely, we think, to result in the best scientific return for the mission. ***The OS encourages the project to continue to work implementing a joint TAC, if not in the first year, then in subsequent years of the mission. The OS also supports the Project's efforts to facilitate more open access to PI-class instruments and data, for example, through archiving and the provision of data pipelines.***

TPF

We appreciated receiving a detailed briefing from Origins Scientist Charles Beichman on the status of Terrestrial Planet Finder, including a helpful discussion of the approach toward selection of the final mission architecture. Two classes are now under active consideration: a visible light coronagraph and a nulling infrared interferometer. Both have strong and complementary scientific justifications, and the ideal TPF program would likely incorporate both types of missions. Because this is not feasible in the near- to mid-term, the Project plans a down-selection to a single architecture around March, 2006. Beichman noted that, because each architecture represents a viable scientific approach, the down-select may be made primarily on technical grounds. On the other hand, Beichman said, the scope of the selected mission – for example, its collecting area, angular resolution, and starlight suppression – will depend strongly on the fraction of sun-like stars that harbor terrestrial planets. True mission success requires the detection of at least 5-10 such planets in order to carry out some degree of comparative planetology. This requirement, together with the fraction of stars with Earth-like planets, will then determine the volume of space that must be searched. This in turn is a strong driver of the mission scope, for example, whether it is the full scope mission that has been envisioned to survey some 150-250 stars out to approximately 50 light-years, or a reduced scope mission to survey about 50 stars in the more immediate solar neighborhood.

For this reason, it is extremely important that every effort is made to place some limits on the fraction of stars with terrestrial planets. Because a definitive answer to this question, which could well come from the Kepler mission, lies well beyond 2006, it is vitally important to consider all other indicators, for example, the fraction of solar system analogs – systems like our own with Jovian planets in Jovian orbits. In addition to the radial velocity studies that are underway, astrometric searches with ground-based telescopes and smaller scale space coronagraphs are promising avenues to increase our knowledge of the fraction of stars with terrestrial planets. We are very pleased with the balanced program that the TPF program has put together for supporting all these efforts.

In thinking about TPF, the OS again discussed the possibility of bringing to the attention of Space Architect Gary Martin the LifeFinder mission as a specific example of how the human spaceflight program could contribute to ambitious future Astronomy & Physics Division missions. In particular, the technology development we saw at JPL in large optics fabrication seems a good place to start. ***We request Gary Martin be invited to join in a discussion of this possibility at our next meeting, at NASA HQ.***

Astrobiology

The OS thanks David Des Marais for his presentation of the new Astrobiology Roadmap, which educated many of us on the detailed science goals and objectives within the program. We are also grateful to Rosalind Grymes for a detailed and informative presentation of the status of the NASA Astrobiology Institute. The NAI is still evolving, and how it performs as a virtual institute is still being defined. However, we were much taken with the characterization of the NAI's main goal as that of facilitating a new discipline in the university and laboratory environment. Dr. Grymes also stressed that the "virtual" in NAI's charter refers not so much to technological solutions for videoconferencing but to the ability to provide a working, evolving environment and interchange between diverse groups of scientists spread throughout the country. ***We***

saw evidence that in this regard the NAI is successfully pioneering a new and important type of institution that could play a major role in future scientific research. The OS looks forward to regular updates on the progress towards the NAI's ambitious goals.

Dr. Grymes put considerable effort into addressing questions and concerns we raised in our last letter regarding the NRC report "*Committee on the Origin and Evolution of Life."* She supplied the OS with a complete (and massive) compilation of papers published by NAI members and abstracted a few examples in the major subdisciplines that are represented – the body of work is indeed impressive. However, we remain concerned about the issue raised by the COEL, the representation of astronomy within the NAI. The OS endorses the NAI's effort to develop an Astronomy Focus Group at NAI. Putting the "astro" in astrobiology means more than counting the number of NAI members conducting astronomically-oriented research, of course. It is just as important that this research effort is integrated into the overall NAI community in order to foster cross-fertilization of the science. This lies at the heart of the NAI mission – the ultimate success of the NAI will be its ability to enable science that would otherwise not have been possible. ***The OS believes it is critical that the NAI evaluate the success of the interdisciplinary activities; one possible metric would be the number of research papers co-authored by scientists from disparate backgrounds, e.g. astronomy, chemistry, geology, and biology, or those that make a clear bridge across traditional discipline boundaries.***

The OS was pleased to hear that graduate students are being trained with some of the interdisciplinary skills that are essential to establishing the new and exciting field of astrobiology.

JWST

At our December 2002 meeting in Washington the OS heard from Anne Kinney, Eric Smith, and John Mather about the replan initiated for the James Webb Space Telescope following the choice of Northrup-Grumman Space Technology (NGST, formerly TRW) as the prime contractor. The goal of the replan is to eliminate the excess $300M from the projected "as-spent" cost over the $1.6B available in present budget planning, and in particular to rephase the work to reduce spending in FY2005-6. We heard that the replan would engage the GSFC Project office, NGST, and the Science Working Group, and that an independent cost assessment was also underway at NASA Langley. We learned from Anne Kinney at this February OS meeting that no solution had yet been found that keeps the full instrument complement of JWST and fits within the cost constraints, this despite considerable efforts to "scrub the costs" by NGST, scientific compromises offered by the SWG, and multiple descopes and reprogramming strategies developed by Project Manager Phil Sablehouse.

The OS believes that the science community is making a good faith effort to reduce scope in an attempt to keep JWST within budget. For example, the extension into the optical (below 1μm) that also had been greatly desired for JWST has been thoroughly de-emphasized, and the SWG has accepted, in principal, significant descopes to NIRCAM and the JWST aperture. Though there are likely to be some additional savings from further scrubbing the science instruments themselves, proposals such as drastic reductions in the number of detector pixels in NIRCAM are especially troubling: it is, we think, somewhat like chopping off one's head in an effort to lose weight. The OS thinks

that cost growth in JWST is little related to the science instruments. In fact, we believe the $1.9B cost for JWST is not inconsistent with the original cost target of $500M (1995) when one considers the adoption of a much larger and deployable mirror than the 4-m monolith that was described in the HST & Beyond report. This more ambitious version of JWST makes excellent sense scientifically, and the OS wholeheartedly supports the current plan. On the other hand, since the impetus for a larger aperture did not come from the astronomical community, there has never been an opportunity to balance instruments specifications and aperture size in order to maximize the science.

Based on Dr. Kinney's comments, the OS recognizes that the magnitude of this budget problem has placed the mid-IR "MIRI" instrument at particular risk. At our previous meeting, the OS restated its long held and frequently expressed position that MIRI will provide an essential science capability for the JWST prime mission, along with a very cost-effective insurance to insure a vigorous science program even in the unfortunate event of losing on orbit either the near-IR camera (NIRCAM) or spectrograph (NIRSpec).

The OS notes that, beginning with the 2000 Astronomy & Astrophysics Decadal Survey, all groups who have considered the issue of JWST instrumentation have regarded MIRI as an essential component of the mission, as the OS has unanimously agreed on previous occasions. The recent WMAP results, which point to an early (z = 10-20) generation of stars that re-ionized the universe, underlines the importance of observing longward of 5μm to insure that a complete picture of this first generation of stars will be well understood. Although born from gas that is nearly devoid of heavy elements, dust produced in a period of simultaneous stellar birth and enrichment may still severely block the light first generation in the rest-frame UV, for which the near-IR camera and spectrograph are the instruments of choice, and at any rate the redder light of the supergiants and supernovae in this first generation will be redshifted beyond the 5μm window. All this relates to the prime mission of JWST, of course; the contribution that MIRI will make in the study of planet formation around young stars is also unique and irreplaceable. We conclude, as others have, that regardless of earlier descriptions of a next-generation space telescope, evolution in the science has made the inclusion of a mid-IR instrument a must.

We have to agree with Anne Kinney that, to this point, the replan effort has not succeeded, since it is unable to find a three-instrument solution within cost constraints. The OS feels that the effort needs to continue, and again urges the Project to take to heart lessons learned by SIRTF in the in the areas of design, development, integration, and test. ***Accepting large, mission-altering reductions in the science capability of JWST, especially before the report of the Langley independent review, would be, the OS thinks, very unwise. The JWST will be the Hubble Space Telescope of the next decade – every effort must be made to find the resources to ensure that it succeeds as brilliantly.***

SIRTF

The OS thanks Mike Werner for his description of ongoing developments of the Space Infrared Telescope Facility prior to its anticipated launch April 18, 2003. The time has been well used to realistically simulate further end-to-end automatous observing blocks and improve other aspects of flight software and the data cycle. The success of SIRTF continues to be of prime importance to the Origins program and the OS looks forward to a successful launch and the beginning of commissioning before its next meeting.

Finally, the OS thanks Mike Devirian's office at NASA/JPL for hosting our meeting and providing some exciting tours of some of the technology development labs at the Lab. It is encouraging to see the progress that is being made on so many key technologies the future of Origins rests.

Let me extend my personal thanks to Anne Kinney and Ed Weiler for the opportunity to chair the Origins Subcommittee and to serve under Steve Squires' and you at the SScAC these past three years. It has been a real pleasure to work with so many smart, dedicated people – on the committees, at NASA HQ, and at the NASA centers – people whose dedication to NASA Space Science ensures a bright future for our ambitious plans and dreams. I'm sure that my successor David Spergel will share my appreciation for their support and encouragement, and be as grateful as I am for the chance to contribute to the most exciting science program on the planet.

Sincerely,

Alan Dressler, Chair, for the Origins Subcommittee